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## *FINAL REPORT*

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# MARKET RESEARCH FOR CO-PRODUCTS OF BIODIESEL PRODUCTION FROM DIFFERENT FEEDSTOCK

**Funded by: The Agriculture Development Fund**

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**Prepared by: Saskatoon Diesel Services Ltd.**

# Market Research for Co-products of Methyl Ester (Biodiesel) Production From Different Feedstocks

Agri-Value Program of ADF
Saskatchewan Agriculture and Food

Final Report
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Prepared by
Saskatoon Diesel Services Ltd. (SDS)

## Abstract

The project was undertaken to determine the market feasibility of producing methyl ester (bio-diesel) and co-products fuel additive from different feedstock of Saskatchewan origin. Several co-products that can be produced from methyl ester producer were researched and are listed in this report.

Due to the nature of using agricultural products as industrial feedstock (supply consistency, price, performance, etc.), it is premature to conclude the extent of market potential and value of co-products from methyl ester production. There is however, significant potential for marketing methyl ester as a fuel lubricity additive. The full potential will be realized when methyl ester is used as fuel and blended as biodiesel, or from the development of certain spin-off products.

For the purpose of this report, "biodiesel" and "methyl ester" will be used interchangeably.

**The project was undertaken to achieve these objectives:**

1. Determine the types of products that can be generated from methyl ester production using mustard, flax, and canola seeds;

2. Determine the market size, market location, prices, and other pertinent information;

3. Identify potential partnerships and alliances from Saskatchewan and elsewhere that could be formed to develop and market the co-products.

The study was conducted as described in the research plan of the Agri-Value application. However, because the first two objectives are inter-related, their results have been combined.

**Co-Products and Market Research**

Co-products are defined as all products created in the biodiesel process. They include methyl ester (biodiesel), glycerin, and seed meal (cake). It should be noted that meal is only a co-product of the process if seed is purchased and then crushed. After crushing, meal is left over to sell and the oil extracted from the seed is used as the feedstock source. Oil is then processed, resulting in methyl ester and glycerin.

**Research Plan:**

There are many databases across Canada that provided the information needed to complete objectives 1 and 2 above. These include AAFC, Statistics Canada, Natural Resources Canada, the National Research Council, provincial databases, and many reports of one kind or another on biodiesel and co-products that have been produced around the world (see small list below – however most reports only involve canola methyl ester). We are interested only in what is suitable for Saskatchewan conditions, so the information in these reports will need to be further distilled to limit them to the specific information that is sought.

There is already a large body of information on co-products available at the University of Saskatchewan and at the University of Regina and their associated research parks and partner organizations (Innovation Place, POS, SRC, synchrotron, etc). AAFC has invested large sums of money into developing world-class research facilities in this province that will provide the backbone to the development of a new industry based on biodiesel and co-products. Many experts working for AAFC and other federal and provincial departments (such as Dr. Martin Reaney of AAFC) were contacted to provide further information that was needed to complete these objectives.

Very interesting, was a contact from Ron Kehrig of AgWest Bio Inc in Saskatoon. Mr. Kehrig put us in contact with Dr. Lou Honary, President and CEO of ELM USA. ELM USA already has a line of bio-based products as listed below. DSG is currently pursuing opportunities (i.e. licensing agreements, etc) with Dr. Honary. In particular, industrial and food grade hydraulic fluids, machinery lubes and greases. These were chosen for their ability to fit nicely with DSG's current product lines.

- Cutting, Drawing, Forming, Quenching, Rolling, Slideway, Stamping and Tapping Oils and Coolants
- Gear Oils, Bar & Chain Lubricant, Concrete Form Release and Dust Suppressant
- Industrial and Food Grade Hydraulic Fluids, Food Machinery Lubes and Greases
- Railroad Curve for Wayside and Hi-rail Application, Heavy Duty Truck Grease, Multi-Purpose Grease, Semi-Truck Fifth Wheel Grease
- Metalworking Tank Side Additives and Cleaners
- Private Label and Custom Bio-based Lubricants

The specific information required to complete Objective 1 above includes the following:

- Product types, characteristics, and uses. The products include, lubricants of various types (automobiles, small equipment such as lawn mowers, marine equipment, chain saws, etc.), oilseed meal (as livestock feed or further fractionation in high-value protein isolates), glycerin (for use in road dust suppressants, cosmetics, pharmaceuticals, detergents, etc.), solvents (for different applications including paint removers), and glucosinolates from mustard meal (for use as bio-pesticides).

- Market size and market trends – will look at the size of the current market for the products and market trends to indicate future markets size based on potential new uses from ongoing research and innovation efforts. Market size included major companies involved, customers and customer groups, to determine the type of partnerships required for developing and marketing these products.

- Distribution – the type of distribution system and network will be determined to determine how products will be integrated into existing systems and networks.

- Value – the value of products based on their current and projected prices will assist in determining the economics of processing.

- Market accessibility – will investigate barriers to market entry and exit, including current government regulations and policies.

The really constructive work, as far as the industry is concerned, involved gathering the information for Objective 3, and linking the information gathered in Objectives 1 and 2 to Objective 3. The research plan for achieving Objective 3 included contacting identified industry players (which included investors) currently involved in processing and utilizing products associated with biodiesel.

The players included national and international transport fleet companies, livestock feed manufacturers and feedlot operators, chemical processors, equipment and small engine manufacturers, companies involved in the nutritional supplements industry, retailers of fuel additives and lubricants, and companies or individuals that have undertaken work in biomass utilization.

New information on potential investors in co-products market was gathered in a systematic way. Federal departments such as Agriculture and Agri-Food Canada, Industry Canada, and International Trade Canada provided a large amount of information on potential investors in this province. Further research on potential entrepreneurs was gathered through the search of web sites, available literature, networking at industry events, etc.

Various Saskatchewan government departments (SAFRR, SIR, etc), and other institutions in the province (STEP, REDAs, AgWest Bio) also provided information from their databases.

## Description of Findings

### *Biodiesel*

On average, 1.5 billion liters of diesel fuel are consumed each year in Saskatchewan.[1] As outlined in the April 2004 report prepared by Andre Hucq, industry experts agree that Saskatchewan-made biodiesel would first have to satisfy the lubricity additive market, which represents less than 1% of diesel sales.[2] Given that maximum production capacity is 500,000 liters per year, virtually all demand for SDS's biodiesel will be in the additive market. With that said, even if additive sales increase 100% each year, the amount of actual biodiesel sold would be minimal. Therefore, biodiesel industry demand growth is heavily dependent on it being successfully integrated as a conventional fuel replacement or as a blend.

In the short-term, potential customers should be within reasonably close geographic locations and not extending past Manitoba, Alberta, and close southern US states. At low levels of production, transporting biodiesel over far distances comes at the high cost. In addition, customers would likely be additive users, as at this point, selling methyl ester as a fuel does not appear to be feasible. Based on an interview with John Skowronski, Director of Environmental affairs with the Canadian Petroleum Products Institute, the market price (net of taxes and markup) charged by producers of biodiesel would be similar to the rack price charged by petroleum diesel producers, which was a $0.50 per liter average in the Prairie Provinces during the month of May.[3] Scott Lewis, a sales representative with Biox provides further support of this, as in his opinion, the market price for biodiesel in Canada should be around $0.90 per liter.[4] Once taxes and transportation costs and mark-up are backed out of this number, the rack price would be similar to that of petro-diesel. However, Biox's plant will not be commissioned until November of this year, so only time will tell if this is accurate.

No person contacted for this study was able to provide a definitive answer on when the mainstream Canadian diesel fuel retailers would view biodiesel as a feasible product to sell in Canada. In general, it appears that large oil companies would not be interested in retailing biodiesel until the rack price of regular diesel and the market price of methyl ester are equal. The reason for this is that a fuel retailer would likely break-even on the sale of the methyl ester component of their biodiesel fuel. (A weighted average price of B2 can be calculated as 98% multiplied by the rack price of diesel at $0.50 plus 2% multiplied by the market price of methyl ester at $1.10, totaling $0.512 per liter. This represents a 1.2-cent premium over the rack price of diesel. After considering additional expenses for handling and blending, the extra cost may total 2 cents.)

The industry rule-of-thumb is that consumers may pay a 2-cent premium for biodiesel fuel (this has not been verified in western Canada), which may cover the additional cost of methyl ester. In essence, the fuel retailers would be removing 2% of their fuel sales by selling methyl ester component at break-even rather than fuel at their standard profit.

In the case of public and private fleets in Saskatchewan, all those interviewed stated it comes down to one major issue...the cost to them, per litre of fuel. Their livelihood depends on purchasing millions of litres of fuel, at the best price they can. They told us even a quarter of a cent per litre affects their bottom lines dramatically. We were told over and over, without fail, "When it is the same price as diesel fuel, and of similar or better quality, come back and see us."

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[1] Hucq, Andre. p48. 2004.
[2] Ibid.
[3] Interview with John Skowronski, Director of Environmental Affairs, Canadian Petroleum Products Institute. June 2005.
[4] Interview with Scott Lewis, Biox Corporation. June 2005.

They were also very concerned about the infrastructure, or lack thereof. Very early in the research, DSG talked to Kocsis Transport's Ron Kocsis. He stated that his trucks could be anywhere between Saskatoon and southern California, so a filling station here would have very limited ability to serve his fleet. This is indeed an issue being addressed by various individuals, including the Renewable Fuels Association of Canada.

For this application and research, a number of fleets were interviewed:

- Epp's Trucking, Saskatoon
- Kindersley Transport, Saskatoon
- Kocsis Transport, Saskatoon
- SaskTel Fleet Manager
- Alberta Motor Association (AMA), Calgary
- SARM
- SUMA
- Association of Student Transportation (School Divisions) AB, SK, BC
- Briggs Bus Lines, Edmonton
- Southland Transportation, Calgary
- Red Arrow Bus Lines, Edmonton
- Yeager Transport, North Battleford
- Richards Transport, Regina

To summarize, most of the fleets listed above said they were interested to see how the industry develops, but until the price is right and the infrastructure is at least somewhat developed, they were not considering biodiesel at this time.

On a positive note, Epp's Trucking is now using a special bio-blend made by SDS for RACK Petroleum. SDS and the RACK came up with the recipe, SDS supplies the product, and it is going into every litre sold by the RACK outlets, albeit at an additive level so far. AMA Calgary also orders regularly, and is splash blending their special blend right at their yards in Calgary.

With SDS's variable production costs of biodiesel projected at $0.81 per liter, it seems that selling biodiesel as a fuel is not an option anytime in the near future. It should be noted that laws are not clear regarding taxation issues in the case where a producer sells methyl ester to a customer, who self-mixes it for use as a fuel. If this were a fuel tax-free option, then it would be another method for SDS to largely increase its production volumes.

At this time, there is little biodiesel sold at the retail level. However, biodiesel can be used as an additive, which has proven to be a highly profitable business for SDS. The company's largest customer purchasing biodiesel (mixed to be an additive) is the RACK, which is mixing it into a 0.1% blend (B0.1) with farm fuel. With an estimated market price of $1.10 in Saskatoon, BioMax Technologies (SDS's biodiesel production company) can produce biodiesel and sell it to SDS at a $0.29 margin. In turn, SDS can continue selling biodiesel in its additives at impressive margins. There is a large opportunity that lies within attaining distribution agreements with large customers. Currently, there have been indicators signaling some potential purchase agreements, but no commitments have been made.

No matter the market, a large factor affecting demand is that biodiesel is relatively new in Canada. Various engine manufacturers have raised concerns about efficiency as well as wear and affect on engines and components. Most engine and/or fuel pump manufacturers will not warranty an engine for more than B5 usage...B20 is being lobbied but is not expecting approval for at least 12 to 18 months. SDS clearly understands hesitation from potential customers, and is currently promoting biodiesel as well as participating in studies to test the effectiveness of this alternative fuel.

***Glycerin***

The following information was provided in telephone interviews conducted with representatives two companies: Dawn Foods Ltd. and Akzo Nobel Chemicals (Saskatoon Plant). Dawn Foods uses glycerin as an ingredient, while Akzo Nobel makes it as a by-product.

Glycerin is used as an ingredient in many food products, but glycerin produced at a biodiesel plant cannot be used for this purpose. Methanol is not a food-grade alcohol, and since it is used as a catalyst in biodiesel production, the glycerin produced is not considered food-grade either.[5] Dawn Foods purchases "further refined" glycerin at a prices ranging from $3.20 to $3.60 per kg.[6] From the interview with Richard Stobbs, site manager of Akzo Nobel Saskatoon, this price could not be obtained by SDS for its glycerin. An estimated price for SDS would be between $0.28 and $1.38 per kg, and likely closer to the lesser of the two.[7] The price discrepancy exists between food-grade glycerin and industrial glycerin because a higher degree of processing is required for the former.[8]

According to Stobbs, companies producing even lower levels than 1 million pounds of glycerin per year tend to have a harder time disposing of it.[9]

In order for glycerin to reach a state where it can be sold as a lubricant or any other specialized product, it must be further refined. This expensive, value-added process should only be undertaken if a unique market is identified and demand is ascertained. At the present time, glycerin is not regarded as highly valuable, nor is it highly profitable. As biodiesel facilities come along, there will likely be a glut of glycerin on the market. European scientists have access to research incentives to find a more practical use for glycerin, so it is evident that producing an undesirable co-product is not SDS's problem alone, nor is it one that the company is expected to solve.

Biodiesel produced with ethanol, as opposed to methanol, creates new opportunities, however. With the ethanol industry developing nicely in Saskatchewan, SDS plans to next do research on the possibilities. Using ethanol was first suggested to us by Dr. Ken Falk at the POS Pilot plant, but he also suggested it was cost-prohibitive...at this time. As the industry develops, the cost should come down.

As a next step, SDS is very interested in exploring the options with ethanol...including foods and pharmaceuticals. According to Dr. Martin Reaney, using ethanol gives the glycerin numerous options, and also changes the qualities of the finished biodiesel product. This will be researched at the same time as the glycerin. Negotiations are currently going with POS for a plan to do just that. Dr. Reaney has given us some guidance as to which products might make more sense to SDS.

As we are currently using methanol, SDS has been in contact with numerous people regarding other uses for co-products. There is fast becoming a "glycerin-glut" in the world...mostly due to biodiesel production. As mentioned previously, last November, SDS had a phone conversation with Dr. Lou Honary, CEO of ELM Manufacturing in Plainfield, Iowa. Dr. Honary has already produced a full line of bio-products using methyl esters and glycerin from the process...or a variation of it. SDS realizes there is a long list of potential products, some of which are listed in the Potential Products section of this application. Once this realization was made, SDS has decided to pick four or five products we think might have the best potential, as well as fit our product line, and do an in-depth due-diligence on them.

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[5] Interview with Zane Labach, Dawn Foods.
[6] Ibid.
[7] Interview with Richard Stobbs, Site Manager, Akzo Nobel Chemicals of Saskatoon.
[8] Ibid.
[9] Ibid.

***Meal***

A parallel feasibility study into biodiesel production concluded that it is more economical for Saskatoon Diesel Services to use raw oil as a feedstock, as opposed to raw seed for crushing. Based on the rationale provided in that study, SDS will not be crushing seed during the pilot-scale stage of production. As a result there will be no meal, so meal will not be included as a co-product.

***Potential Products Derived from Co-Products***

The following is a list of product opportunities for oleo chemicals, which include glycerin and fatty esters. It is not a comprehensive list, but it details some major product opportunities that have already been identified. For some products, they could likely be made directly from the methyl ester and glycerin produced in the biodiesel process. Others would involve some degree of further refining. This list is taken from the European Oleo-chemicals and Allied Products Group website: www.apag.org/oleo/index.htm

*Note:* It is not feasible to describe the characteristics of each product as the chemistry is already well established in the public domain. The intent is to show the potential scope and range of products that can be manufactured and therefore the potential opportunity that exists for co-products of biodiesel production. Furthermore, it was determined at the beginning of the study that the market size and market trends of co-products are not feasible under the project budget. It was also determined that this information will not contribute significantly to determining the economic viability of biodiesel production.

Soaps and Detergents
- Industrial and domestic.

Health and Personal Care
- Culture media, tableting aids, shampoos, soaps, creams, lotions, make-up.

Food
- Emulsifiers and specialties for bread, cakes and pastries, margarine, ice cream, confectionary.

Industrial Lubricants
- General and specialty lubricants, base oils for non-toxic biodegradable lubricants.

Metalworking and Foundries
- Cutting oils, coolants, buffing and polishing compounds.

Mining
- Froth flotation of ores, surface-active agents for oil-well drilling muds.

Paints and Coatings
- Alkyd and other resins, drying oils, protective coatings.

Paper Re-cycling
- Removal of printing ink

Plastics
- Stabilizers, plasticizers, mould release agents, lubricants, anti-statics, anti-fogging aids, polymerisation emulsifiers.

Printing
- Printing inks, paper coatings, photographic printing.

Solvents
- Non-toxic graffiti, bubble gum remover

**Feedstocks**

During the numerous meetings, seminars, and research done by SDS, it was made quite clear that not all feedstocks are created equal. An interesting quote came from Dr. Reaney when asked if flax would make a good quality biodiesel. His answer was, "Flax tends to make paint." That being said, Dr. Reaney has done testing on Solin flax, and the results are positive. He is still performing that research.

Because canola was somewhat proven to work, Dr. Reaney suggested we test mustard...oriental mustard to be exact. Yellow mustard is made for the condiment market, and is a limited market to begin with. Dr. Reaney said early research indicated that oriental mustard oil had qualities most similar to canola, and that the meal offered superior alternatives to canola meal i.e. for bio pesticides, etc., due to the glucosinolates.

Very interesting is the thought of a biodiesel "hybrid" so to speak. Dr. Reaney is very keen on a variation of Brassica Juncea. The variation is basically, "...a mustard with canola qualities." Dr. Reaney says the seed could be modified to make "the perfect feedstock for biodiesel". Scientists are working on this, as this application is being submitted.

While canola and mustard have been proven superior in many ways, some have been proven sketchy, to say the least. One quality that sets them apart is pour-point...the temperature at which the fuel begins to form wax crystals. Canola leaps to the top of the list in this category. Rendered animal fats and used deep-fryer oil head straight to the bottom...sometimes crystallizing substantially above 0 degrees Celsius. We found mustard and canola can go as low as -12 degrees C, and that has proven to be a very desirable trait around the world.

Other varieties being researched (that we are keeping an eye on) are camelina, chokecherry, and jatropha, to name a few. These are listed because they seem to be the most positive options to date. There are also researchers looking at old canola varieties, as well as developing new varieties, with oil and/or meal qualities that suit this industry better. The leading scientists say we should have a "Cinderella crop", perfect for this industry, very soon. SDS keeps in close contact with these researchers, for just such an occasion.

**Conclusions from this study:**

**Objectives:**

1. Determine the types of products that can be generated from biodiesel production using mustard, flax, and canola seeds;

SDS has taken note of the various types of products that can be generated from the production of methyl ester, and the list seems to grow larger every week. Biodiesel as a blended fuel (over 1%) from Canadian oilseeds is not feasible at the present time, so SDS has begun looking at feasibility of various spin-off products. Spin-off products hit niche markets and allow for higher margins, so SDS will develop one or two and then take them to market. SDS has already narrowed the list down to five potential and very feasible products.

Criteria for these products will include:

- Ability to make them with minimal adjustments to the recipe developed by SDS
- A close fit with SDS's current line of products and services
- Markets needing replacement of environmentally harmful products as per Kyoto
- Must have marginability comparable to the current bio-additive line

SDS's next step will be the research and development of these products.

2. Determine the market size, market location, prices, and other pertinent information;

As the methyl ester industry is still in its infancy (but growing fast!) in Canada, SDS will focus its initial marketing efforts in Western Canada. Bio-additives will be the main focus, while spin-off products will be looked at individually as they join the product line. *One potential spin-off product is of particular interest to Canadian cities, in particular, and they have requested any and all information as soon as it is available.

With the discovery that methyl ester as fuel is not feasibly yet, SDS plans to take the additives to the next level. This involves appointing a marketing specialist dedicated solely to bio-additives. SDS has recently hired Gerald Tornato to take the bio-additive line national. Mr. Tornato has just recently returned from eight weeks in Ontario, where he met with many potential partners. Rather than send him back there on a weekly basis, Mr. Tornato focused on developing a few distributors in specific areas of that province. The trip was very successful.

3. Identify potential partnerships and alliances from Saskatchewan and elsewhere that could be formed to develop and market the co-products.

Potential partnerships have been explored throughout this endeavor, and talks are currently under way with five interested parties from British Columbia through Manitoba and now into Ontario. These talks currently involve bio-additives, bulk bio-fuel blending, and two of the possible spin-off products. Efforts are ongoing to engage other partners and investors for a proposed methyl ester manufacturing facility.

Companies that have come on board already are:

1. Federated Cooperative Ltd Saskatoon, SK – Available to all branches
2. RACK Petroleum Biggar, SK – In every litre of fuel sold at all branches
3. SDS's full dealer network
4. MacEwan Petroleum Maxville, ON - 80 branches ON and QC
5. Chalmer Fuels - Palmerston, ON - 2 outlets
6. Lazotte Fuels – Sudbury, ON - 3 locations
7. Dymtar Rosebush – Pickton, ON - 2 outlets
8. Outram Fuels – Lindsey, ON
9. Niagra Performance Diesel St. Catherines, ON

Pending – In discussions

1. United Farmers of Alberta (UFA) Calgary, AB
2. EcoSol Fuels Mission, BC
3. Verreault Timmins, ON - 3 locations
4. McDougall Fuels 80 locations
5. Mackey Fuels North Bay, ON
6. Jack Smith Fuels Comber, ON - 2 locations
7. Durham Mack Truck Ajax, ON
8. Sylvite Fuels – London ON
9. KBM Merchandising Barrie, ON
10. Complete Western Truck and Service Barrie, ON
11. ProNorth Transportation North Bay, ON
12. Cliktech Toronto, ON
13. Permatex Toronto, ON

A recent development has arisen with an interested farmer group from Davidson. After a few initial meetings, a project is pending, and it is almost completely due to information gained and alliances made from performing this study in the Craik/Davidson corridor.

Overall, this study has provided significant information towards the development of a business and marketing plan for methyl ester from Saskatchewan oilseed crops.

**Events at which SAF project funding was acknowledged:**

1. Press conference on the Saskatoon Princess riverboat.
2. Two industry/research/member meetings put on by AgWest Bio.